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# A cognitive model to enhance professional competence in computer science

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**Abstract**

The paper presents the results of the cognitive modeling of the COMPUTER SCIENCE terminological system in the form of a thesaurus. The thesaurus comprises over 3000 units, which are drawn from explanatory monolingual and bilingual dictionaries of computer science terms representing the basic phenomena and processes in the professional context. Methodologically, the analysis is based on the frame model and focuses on semantic relations specific to the sphere of computer science in terms of ontological and epistemological features. The thesaurus facilitates the detailed description and effective arrangement of the terminological system characterized by a complicated hierarchical structure, and thus plays a crucial role in forming and developing professional competencies.



*Keywords:* Professional communication; terminological system; cognitive approach; thesaurus; frame model

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## 1. Introduction

Terminology is inextricably linked with thinking, which reflects the dynamic process of human perception of reality. Terms are special cognitive-informational structures, which accumulate the special knowledge gained by mankind and expressed in specific linguistic forms. Acting as carriers of professional and scientific memory, terms become an intermediary in the process of special communication, leading to the mastery of a certain situation [1]. Terms are reflect the results of people's experience and practice; they record knowledge about the properties of objects and phenomena, and reveal their most significant features.

Of great significance in developing professional competencies are ways of presenting the basic terms of a particular professional sphere and their relationships with each other. Cognitive modeling of terminology in a professional sphere consists in searching for cognitive foundations for the systematization of special knowledge fixed in terms, and serves to build an integrative model of knowledge reflecting the real situation in the professional field. A number of publications on cognitive modeling deal with mind mapping, which involves taking information from various sources and displaying it as keywords in a bright, colorful manner [2]. In medical science, this technique is shown to be effective in helping medical students organize and retrieve information [3], write and review notes quickly and update information easily [4], besides it can be used as a means of controlling the level of mastering the material, especially at the beginner's level [5]. However, in computer science, some scholars doubt in the efficiency of the method and mention its principles like radiant thinking, individuality and axiomatic nature as grave disadvantages [6].

Close but not equal to the concept of mind mapping in modern terminology is a systematic description of special terms using the thesaurus approach. In recent terminology studies, the thesaurus approach has been used to describe the terminological systems of such professional fields as archaeological material science [7], civil engineering [8], telecommunication terminology [9], financial markets [10], environmental audit [11], and aviation ecology [12]. These studies focus on semantic relations (hyper-hyponymic, partial, causal, etc.) specific to each of the given professional spheres in terms of ontological and epistemological features.

This study is devoted to modeling terminology of computer science as a way of representing and systematizing special knowledge in this sphere. It aims to identify and classify the system relations of terminological units as well as model a multilevel terminological field of the subject area under analysis. The paper reveals the complicated hierarchical structure of the computer science terminological system and presents a thesaurus that is designed to reflect established professional knowledge and facilitate the detailed description and effective arrangement of the terms belonging to the given area.

## 2. Methodology

Cognitive analysis allows systematizing terms in order to reflect established professional knowledge. Any potential professional activity is concentrated on a specific object, and an image of the object arises in the consciousness of specialists, and it defines all further actions in the professional sphere. Definitional analysis of relevant sources (dictionaries, glossaries, textbooks, scientific literature) in computer science allowed identifying the meaningful structures and system-forming categories relating to specific areas of special knowledge in computer science. As a result, 9 system-forming categories were identified: program product, computer, programming language, syntax and semantics of a programming language, subprogram, data and their structure, object-oriented programming, information search and sorting, computational complexity. These system-forming categories combine the terminological units of the study area into a single cognitive formation, which will later form a corresponding section in the thesaurus.

Terminological units relating to a particular area of special knowledge are interconnected by semantic relations (or thesaurus functions [13-14]) of different kinds: hyper-hyponymic, gradual, polar, partial, causal, etc. The systematization of computer science terms presupposes the existence of some kind of reference point, i.e. a feature, on the basis of which the terms of a specific thematic group can be compared. Thus, in hyper-hyponymic relations, classification concepts designate generic concepts and lexicalized concepts in relation to other elements of the model. Classification concepts change with a change in the situation and purpose, with a change in the vision of a fragment of reality by a specialist in the field at a given particular moment, which indicates their dynamism. When choosing different points of reference, the structure and volume of the model change. Thus, cognitive modeling expands the

possibilities of terminology systematization, reflecting special knowledge about the corresponding phenomena and from the relationship between them.

## 3. Cognitive modeling of computer science terminology

In the thesaurus, semantic relations (thesaurus functions) are considered as paragraphs of the questionnaire presented for each term. This idea was proposed by S.E. Nikitina and first implemented for the terminology of Applied Linguistics [13] and then for the terminology of Stylistics [14]. For each field of knowledge, the list of semantic relations, in addition to the most general ones, is specific due to the ontological and epistemological features of the particular area of knowledge. Therefore, in this study the list of thesaurus functions was supplemented and adapted to the conceptual system of computer sciences.

All in all, the thesaurus comprises over 3000 units, which are drawn from explanatory monolingual and bilingual dictionaries of computer science terms and other sources like textbooks and scientific literature representing the basic phenomena and processes in the professional context. In terms of structure, each entry in the thesaurus consists of two parts: it contains (1) a definition and (2) a thesaurus part. The thesaurus part reveals 15 semantic relations (or thesaurus functions) that contribute to obtaining comprehensive information about the term in question. As an illustration, Table 1 shows the 15 semantic functions described in the entry "Algorithm".

Table 1. An example of an entry in the thesaurus. Algorithm.

| Semantic function | Definition |
|---|---|
| Definition/is a | a prescribed set of well-defined rules or instructions for the solution of a problem |
| Quasi-synonym | logic |
| Synonym | a sequence of operations, a set of guidelines, a set of instructions |
| Generic concept | technology |
| Type | recursive, logical, serial, parallel, distributed, sorting, iterative, combinatorial, graph, sequence, selection, insertion sort, subsequence, backtracking, divide and conquer, brute force, randomized |
| Whole of | program |
| Part of | acquire data, computation, selection, iteration, report result |
| Has a function | problem solution, performing calculation, data processing, automated reasoning |
| Uses instrument | - |
| Has property | finiteness, definiteness, effectiveness, input, output |
| Process | algoritmization, programming |
| Expressed in/via | natural language, pseudocode, programming language, flowchart, control table |
| Used by | software developers |
| Used in | a computer, a biological neural network, an electric circuit, a mechanical device |

The semantic relations are expressed with the help of various standard phrases. For instance, the semantic function *"Whole of"* can be expressed by means of such phrases as *"B consists of A", "B includes A", "A functions as a part of B"*. Or the semantic function *"Uses instrument"* can be expressed by means of *"By means of, when applying, when using B", "A accompanies B", "A involves B"*, and so forth. The semantic relation *"Function"* can be expressed with the help of phrases like *"A expresses B"*, *"A is used to express B"*, *"A denotes B"*, *"A is necessary for B"*, *"A is a*

*formal indicator of B"*, etc. To express the semantic function *"Context (or Used In)"* the following standard phrases can be used: *"A is used in B"*, *"A relates to B"*, *"A is a term for B"*.

In the learning process, each entry in the thesaurus can be further expanded into a coherent text, which relates to a framed piece of special knowledge. Being connected, these fragments reveal a complicated hierarchy that characterizes the professional sphere of computer science, and add up to the whole picture of subject knowledge.

## 4. Conclusion

The thesaurus is a source of special knowledge in the subject area; it is a way of regulating, describing and systematizing the terms of a specific professional field. It facilitates the detailed description and effective arrangement of the terminological system, which is characterized by a complicated hierarchical structure. In this way, it plays a crucial role in forming and developing professional competencies. Moreover, due to the clear structured presentation of different types of information, thesauri allow you to quickly fix new patterns and trends in the development of conceptual systems, clarify the patterns that have already been obtained, without changing the structure of dictionary entries.

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